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HOSPITAL TECHNICAL MEMORANDUM

PRESSURE STEAM STERILIZERS

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Pressure Steam Sterilizers

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I. Scope

1. This Memorandum gives guidance to hospital authorities in respect of the purchase, installation, testing and maintenance of steam sterilizers. Attention is drawn to the relevant British Standards. The Memorandum makes recommendations about the types of sterilizer considered suitable for hospitals of different sizes. The Appendices cover certain aspects not fully dealt with in the body of this Memorandum.

II. Introduction

(i) British Standards

2. The British Standards Institution, 2 Park Street, London, W.1, has published the following standards in respect of steam sterilizers for hospital use:

B.S. 3970

Part 1 Sterilizers for porous loads

Part 2 Sterilizers for bottled fluids

Part 3* Sterilizers for unwrapped instruments and utensils

Part 4* Small electrically heated steam sterilizers for unwrapped instruments and utensils.

All sterilizers conforming to the British Standard are automatically controlled.

3. Sterilizers to this British Standard are not to be used in anaesthetizing sites.

4. Intending purchasers of sterilizers are recommended to study the current editions of the relevant parts of the standard in conjunction with this Memorandum, which is supplementary to them. The guidance of the Ministry should be sought before a decision is taken to purchase sterilizers of a type not in accordance with standard.

(ii) Ministry policy

5. Ministry policy is outlined in the Report prepared by the Joint Committee of the Central and Scottish Health Service Councils on central sterile supply departments issued under H.M.(67)13, dated 6th March, 1967. H.M.(67)13 and Building Note 26 recommend that all theatre instruments and utensils should be sterilized centrally either in a Theatre Sterile Supply Unit (T.S.S.U.) or in a Central Sterile Supply Department (C.S.S.D.).

6. It is considered undesirable to install sterilizers designed for more than one process, e.g. both textiles and fluids; both steam and ethylene oxide.

(iii) Steam supply

7. Pressure steam sterilizers require a steam supply either from an existing boiler plant or, where such a supply is not available or is unsuitable, from an independent steam generator. A British Standard for Steam Generators for this purpose, B.S. 3970, Part 5, is in course of preparation.

8. It must be emphasized that a continuous supply of dry saturated steam at 50/60 p.s.i.g. is required if sterilizers conforming to B.S. 3970, Parts 1, 2 and 3, are to operate correctly. If there is any possibility that the available steam supply will fail to meet this requirement at any time, consideration should be given to providing a separate steam generator for the sterilizers. There is evidence that excessive fluctuation of steam pressure is more common than is generally supposed. A sterilizer made to B.S. 3970, Part 4, does not require a separate steam supply.

III. Types of sterilizer

(i) Sterilizers for porous loads (B.S. 3970, Part I)

9. These sterilizers are intended to deal with textiles, dressings, equipment made of rubber (e.g. gloves), wrapped instruments and wrapped utensils. Sterilizers in this category are provided with means to evacuate air from the chamber prior to the admission of steam for sterilization, and to dry the load by vacuum after sterilization.

(ii) Sterilizers for bottled fluids (B.S. 3970, Part 2)

10. Sterilizers conforming to the standard must be of rectangular form. They are of the downward (" gravity ") displacement type. The standard makes provision for the fitting of the following optional extras:

(i) A rapid cooling device.

(ii) Means for maintaining equilibrium pressure in the chamber and bottles during cooling (" air ballasting ").

If either of these devices is not required initially but may be required in the future this should be mentioned when a sterilizer is ordered.

(iii) Sterilizers for unwrapped instruments and unwrapped utensils (B.S. 3970, Part 3)

11. These are of the downward displacement type. Instrument and utensil sterilizers are intended to deal with unwrapped instruments and unwrapped utensils within a complete cycle time of 10 minutes. Machines which have recently become available, operating at 150°C (50 p.s.i.g.) held for a few seconds, do not comply with B.S. 3970, Part 3.

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* In course of preparation

IV. Sizes of sterilizers

(i) Sterilizers for porous loads

12. It is difficult to give precise information on the sizes of sterilizers required for particular hospitals. It is assumed that all new general hospitals will be served by a C.S.S.D. and studies are being undertaken into the sterilizer capacity required. Guidance on the provision of sterilizers for a C.S.S.D. will be found in Building Note 13.

13. For those existing hospitals without access to a C.S.S.D. some guidance on size may be useful. From rough calculations based on practical experience in a number of hospitals it is reasonable to suppose that where an average amount of surgery, casualty and out-patient work is done, the daily through-put of sterile materials (other than theatre instruments, bowls, fluids and pharmaceutical products) could be handled in a normal eight-hour day by sterilizers of the following sizes:

For groups up to 250 beds

A sterilizer of approximately 4·5 cu. ft. gross volume (e.g. 18 in. diameter by 30 in. long, cylindrical).

For groups of 251-500 beds

A sterilizer of approximately 10 cu. ft. gross volume (e.g. 26 in. by 26 in. by 26 in., rectangular).

For groups of 501-1,000 beds

A sterilizer of approximately 14 cu. ft. gross volume (e.g. 36 in. by 26 in. by 26 in., rectangular).

Since there is only a small difference in cost between the 10 cu. ft. and the 14 cu. ft. chamber size, consideration may be given to the advisability of using the larger size in the case of groups of 251–500 beds.

A porous load sterilizer conforming to B.S. 3970 is required to complete its cycle of operations in not more than 30 minutes. Consideration should be given to the use of an existing C.S.S.D. before replacing any porous load sterilizer which is not in a C.S.S.D. and before purchasing any new porous load sterilizer for use anywhere else in a hospital.

14. Sterilizers of the same type in a particular installation should preferably be of the same size and made by the same manufacturer.

15. A reserve sterilizer should always be installed in order to provide adequate sterilizing capacity to cover normal maintenance, breakdowns, or emergencies requiring an increased volume of sterile materials.

(ii) Sterilizers for bottled fluids

16. It is now generally accepted that the best method of providing sterile water is by the use of individual bottles. The size of sterilizer required will be determined by the number of bottles to be sterilized in a given time. The daily load may be dealt with in one cycle of several hours duration or by several shorter cycles, using a rapid cooling device. If a rapid cooling device and/or air ballasting is required this must be specified in the invitation to tender. Such devices are relatively expensive and involve some hazard of contamination by cooling water and ballast air entering the bottles, unless care is taken to ensure that bottles have effective seals.

17. On many bottled fluids sterilizers fitted with rapid coolers the chamber condensate is collected for use as the coolant; if a bottle breaks in the chamber the contents will therefore flow into the coolant pipework and tank. For this reason it is usual to flush the cooling system of such machines after the breakage of a bottle of saline solution; it is usual in any case to flush the system periodically. (See Weekly Tasks, Appendix 7.)

(iii) Sterilizers for unwrapped instruments and unwrapped utensils

18. Where, in existing hospitals, separate sterilizers are required for individual theatres, one sterilizer 12 in. diameter by 20 in. long and complying with B.S. 3970, Part 3, is generally sufficient to meet the needs of a single operating theatre.

V. Noise levels

19. Sterilizers cause air-borne and structure-borne noises when working. It is recommended that:

(i) The vacuum pump and motor assembly, compressors and similar assemblies be fixed on separate resilient mountings. It may be necessary to provide sound insulation jackets for such items.

(ii) The whole sterilizer assembly be secured on properly designed resilient mountings or, if built-in, isolated from the building structure by machinery cork.

(iii) All pipe connections to services, e.g. for steam, water, condensate, air, etc., should be of an adequately flexible type.

(iv) Open louvres in doors and internal walls should be avoided if the sterilizer room is in the main building, and doors should be self-closing and well sealed. (Attention is drawn in para. 52 to the need for a properly designed ventilating installation to cope with the steam and heat.)

(v) When any sterilizer is operating in a C.S.S.D. the sound pressure level should not exceed the International Organization for Standardization (I.S.O.) noise rating number of 55 when measured at any point 12 ft. from the sterilizer.

(vi) When any sterilizer is operating in an operating theatre the sound pressure level should not exceed the I.S.O. noise rating number of 30 at any point 6 ft. from the sterilizer.

(vii) The maximum noise rating of sterilizers in other noise sensitive areas may be 40 to 45 as appropriate to the location.

VI. Specifications to be included in hospital tender documents

(i) General specification

20. The specification should state that the sterilizer must comply with the appropriate part of B.S. 3970 and with any additional requirements as indicated in this Memorandum.

21. All invitations to tender for sterilizers should request full information from the manufacturers on all services and connections to be provided by the hospital for operating the sterilizer. The services required may include:

(i) Steam supply (see Appendix 1).
(ii) Electricity. The specification should state the type of supply available, whether D.C. or A.C., and the number of phases, the voltage and frequency.
Note: A heavy electrical loading may be required if a local steam generator is used.
(iii) Water supply for condensers, water sealed pumps and sometimes for rapid cooling devices on sterilizers for bottled fluids.
(iv) Condensate return from the jacket, steam separator and traps.
(v) Open gravity condensate drain for the chamber.
(vi) Waste cooling water outlets for condensers.
(vii) Compressed air for air ballasting on some bottled fluids sterilizers and for air operated valves or other mechanisms on some sterilizers.

22. It should be required that clear and simple instructions for operating the sterilizer be prominently displayed in indestructible form on the operating panel. These instructions should be suitable for the guidance of staff unfamiliar with the machine.

23. The type and standard of packing for delivery of the sterilizer should be specified unless the manufacturer is to be responsible for the installation of the machine.

24. Consideration must be given to the probable conditions of installation (e.g. whether the machine will be installed and used at once, or will be positioned adjacent to building operations in dusty conditions, or will stand on the site unconnected for a long period). It may be necessary in some cases to specify dustproof packing and a substantial transit case to prevent damage on site.

25. The manufacturer should be required to supply two complete sets of technical literature on the operation, maintenance and overhauling of all items of equipment incorporated in the sterilizer, as well as two copies of record drawings showing the pipework and electrical circuits on the machine itself. The literature must include a complete planned preventive maintenance (P.P.M.) programme. This programme must show the tasks to be performed weekly, six-weekly, quarterly, half-yearly and yearly. The manufacturer must also supply an insurance test certificate.

26. Adequate arrangements will be required for the regular servicing of sterilizers. If is often convenient to enquire at the time of tendering about the terms and conditions of a suitable servicing contract.

27. The manufacturer should be required to tender for quarterly maintenance inspections during the first year and submit written reports promptly on the result of each inspection.

28. The manufacturer should be required to undertake to replace, free of cost to the purchaser, any part of the sterilizer found, within 12 months of the handing-over date, to be defective due to faulty materials or workmanship.

(ii) Particular specification

29. Where B.S. 3970 permits alternatives, the particular specification should state which alternatives are required or are acceptable. A schedule of the British Standard Clauses which contain alternatives is given in Appendix 2.

30. A cycle counter should be provided to assist in maintenance assessments.

31. If the water supply pressure is critical for the effective operation of the sterilizer, the manufacturer should be required to fit a pressure gauge on the service connection. This gauge should be marked to show the minimum and maximum acceptable working pressure. A warning light, visible to the operator, should indicate when pressure falls below the recommended minimum.

32. The proposed location of the sterilizer and the appropriate I.S.O. noise rating should be stated clearly in the specification.

33. It is desirable that sterilizers can be readily modified for use as either free-standing or built-in units. Side, back and roof panels of free-standing sterilizers should be readily removable to facilitate maintenance.

34. Power-operated doors are desirable on the larger sizes of porous load and bottled fluids sterilizers. Designs at present available are:

(i) Sliding door (vertical or horizontal).
(ii) Side-hinged doors.
(iii) Fixed bed-plate (or door) with a chamber which is raised vertically.

The application of sliding doors to sterilizers is a fairly recent development with certain advantages, while hinged doors have been successfully used for many years. In (i) and (iii) the possibility of the operator touching the hot inside face of the door is reduced. Other considerations may influence the choice of system

in any particular installation; for example, space restriction, price and ease of maintenance.

35. In some cases sterilizers are asked for with a door at each end, but this type of construction presents an additional manufacturing complication and, when the sterilizer is under reduced pressure, gives rise to a greater danger of air leak.

36. If hinged doors are required, the specification should state whether these are to be hinged on the left-hand or right-hand of the opening.

37. A suitably accurate vacuum gauge, together with isolating valve, should be provided on porous load sterilizers for " leak test " purposes. The gauge should have a range of the order of 0 to 100 mm. Hg. absolute. The gauge should be not less than 4 in. square or 6 in. diameter.

38. Means must be incorporated to enable the hospital engineer or other authorized person to carry out the leak test without difficulty.

39. Any strainer in the steam, condense, drain or water line must be located in a readily accessible position. Strainers in chamber drains should be properly secured.

40. Recording thermometers, showing the time/temperature over the ***complete cycle*** should be fitted to all porous load and bottled fluids sterilizers. The sterilizing period in the cycle should be represented on the chart by a line not less than 15 mm. long. It should be appreciated that the recorded temperature is not necessarily the temperature in the centre of the load, though it may approximate to this temperature. The correct interpretation of the recorded temperature requires experience and a knowledge of the instrument on the particular machine. (See Appendix 7, para. 9.)

41. Where a rapid cooling device is required, the specification should state that if the cooler offered is of the condensate-collecting type the manufacturer should indicate the means by which the system may be flushed and the frequency at which such flushing operations should be carried out after solutions have been sterilized. Manufacturers should also be advised that it is desirable that the flushing operation can be carried out by the sterilizer operator or the Superintendent alone. On some machines a push-button flushing cycle can be provided at a relatively small extra cost.
Note: The design of the sterilizer must be such that it can be safely operated manually as a naturally cooled machine in the event of failure of the cooler, and un-ballasted (using conventional bottles) in the event of failure of the air-ballasting equipment.

42. The manufacturer should be required to provide a suitable steam reducing valve or valves, with a separator on the high pressure side of each reducing valve.

43. A connection should be provided on the steam supply line to enable steam samples to be taken.

44. The manufacturer should be required to state the heat losses from all sources on the machine, into the working area and into the maintenance area, at an ambient temperature of 20°C. It is desirable that the thermal insulation be easily removable and well protected to prevent flaking during removal and replacement.

45. The manufacturer should be informed that after installation each sterilizer will be submitted to functional acceptance tests. The tests for porous load sterilizers will be all those specified in clause 25 of B.S. 3970. This clause is about to be revised. In the case of sterilizers for bottled fluids the test to be passed is that described in Appendix 3; in the case of sterilizers for unwrapped instruments and unwrapped utensils the test is that described in Appendix 4 of this Memorandum.

46. If difficulty is encountered when considering tenders, reference should be made to the Director of Scientific and Technical Services, Ministry of Health, for advice.

VII. Installation

(i) General

47. Sterilizers should be sited and installed after careful planning, in which the problems associated with the steam supply and with maintenance are fully examined. The engineers who will be responsible for maintenance should be consulted throughout the planning and purchasing stages.

48. The variations in details of different manufacturers' designs are not significant for planning purposes except in the case of one porous load sterilizer, the chamber of which is raised vertically. Appendix 5 gives planning data covering space requirements (including space required for maintenance purposes) and services requirements. The information is intended as an initial guide for planning purposes. It does not cover the space required in front of the machine but adequate circulating space must be provided for the manoeuvring of the loading carriages where these are used. The exact details for a particular sterilizer should be obtained from the manufacturer in each case.

49. Where the sterilizer is built in, provision should be made for fitters to gain access to the maintenance

area without having to enter the sterilizing room. Provision should also be made for convenient access from the maintenance area to the front panel of the sterilizer.

50. Access for maintenance should be provided at both sides of any sterilizer which is fitted with a door at each end. If this is not possible access should be from the front of the non-sterile end. Space requirements for maintenance of this type of sterilizer are similar to those required for the single door sterilizer shown in the sketch.

51. Most machines do not require special foundations. Careful attention must be paid to height adjustment, especially where several machines are to be served by a common loading carriage, and also to effective drainage from chamber and jacket. Attention must, of course, be paid to the noise attenuation problem when the foundations are designed.

(ii) Ventilation

52. Careful attention must be paid to ventilation of the sterilizing room and the maintenance area. The amount of air introduced for this purpose must be related to the heat loss from the plant as well as to the vapour produced in and around it. The high temperature and humidity in the vicinity of sterilizers may produce uncomfortable working conditions and have an adverse effect on some types of automatic control equipment. Steam vapour should not be allowed to discharge into the sterilizing room but should be collected and extracted from the room. Tundishes receiving hot condensate should be sited so as to avoid condensation on electrical equipment.

(iii) Water supply

53. A water supply of adequate quantity and, for some makes of sterilizer, constant pressure is required. Water may be supplied by a direct connection to the water authority's mains using a reducing valve as necessary. If, however, this infringes the authority's bye-laws or the water pressure is too high, too low or subject to excessive fluctuation, an alternative supply, usually from a break-tank, must be provided. A pump may be necessary in some cases. Sterilizer manufacturers usually quote as an extra for providing such an alternative supply.

(iv) Drainage

54. The airbreak tundish should discharge by gravity into a suitable foul drain connection of adequate size. Condensate from the chamber may be contaminated and must pass via the tundish to the foul drain. Condensate from the jacket, steam separator and other trapping points on the steam pipework may be recovered. If it is to be recovered, a connection must be made into the system condensate return. If it is not to be recovered, it may be discharged into the tundish.

(v) Pipework arrangements

55. All steam pipework must be designed so that any condensate flows by gravity in the same direction as the steam. This general principle applies equally to steam mains, branch connections and pipework on the sterilizer itself. Care must be taken to trap and drain any condensate which may be collected in pockets in the pipework or the sterilizer.

56. A discharge pipe from the pump to atmosphere may be required. Some types of pump (e.g. oil-sealed pumps) need a catchpot in the discharge pipe to prevent precipitated vapours draining back into the pump. Such a discharge pipe should run downwards from the pump to the catchpot before rising to atmosphere.

57. Care should be taken to ensure that sterilizers are connected to mains services which are of adequate capacity and otherwise suitable for the sterilizer load requirements. Inadequate services may cause malfunctioning. For instance, water actuated valves may operate out of sequence if the water pressure fluctuates because of demands from w.c. cisterns, baths, etc., connected to the same cold water service pipe.

58. The design of the steam supply pipework should be checked to ensure that it is capable of meeting the maximum steam demand for short periods without a fall in pressure below 50 p.s.i.g. before the reducing valve. The effect of nearby connected equipment (e.g. laundry equipment) on the steam demand and steam pressure should be carefully considered.

(vi) Steam separator and reducing valve

59. The quality of the steam is of vital importance to the performance of any sterilizer. Wet steam is a common cause of wet loads in porous load sterilizers. It is essential that dry saturated (not super-heated) steam is fed into the sterilizer chamber.

60. The manufacturer is responsible for supplying the separator and reducing valve for the machine. If the sterilizer is to be located very near a boiler it may be necessary to take special steps to prevent super-heating of the steam by the pressure reduction.

61. Reducing valves for sterilizers need very careful selection. The advice of the sterilizer maker should be sought before any new reducing valve is fitted to an existing sterilizer.

(vii) Safety valves

62. Careful attention must be paid to the location of all safety valves to ensure that effective protection is afforded to both chamber and jacket regardless of the closure of any associated control valve. The safety valve discharge pipes should be of a size not less than one-and-a-quarter times the nominal size of the valve. Any rising discharge pipe must be fitted with a drain at the lowest point. The discharge pipe must terminate in a safe visible position, not exposed to frost.

(viii) Steam service

63. Arrangements should be made for the steam service system to be thoroughly examined and for any defects to be remedied before a sterilizer is put into

service. Some important comments on steam requirements have already been given in para. 8 and further notes on this subject are in Appendix 1.

(ix) Commissioning procedure

64. Arrangements should be made to ensure that all staff concerned with the operation and maintenance of the sterilizer have ready access to manufacturers' instructions and service manuals. Sterilizers should be commissioned, using the procedure in *Hospital Engineering Services Commissioning Manual No. 5—Sterilizers and Disinfectors* and *Hospital Engineering Services Commissioning Manual No. 2—Miscellaneous Components.*

VIII. Maintenance and operating policy and procedure

65. The importance of adequate maintenance was emphasized in the Report referred to in para. 5.

Paragraph 12 of the Report states:

"(xii) ***Maintenance of Sterilizing equipment*** . . . Regional Hospital Boards should designate an officer having the primary responsibility to ensure that all sterilizing equipment is maintained properly."

H.M.(67)13, para. 6, reads:

". . . Where Boards have not already arranged planned maintenance of C.S.S.D. equipment and sterilizers this should be done as soon as possible."

IX. Routine testing

(i) Bowie/Dick test

66. The presence of even a small quantity of air in the chamber of a porous load sterilizer during the sterilizing period affects the sterilizing cycle adversely.

The presence of this air may be indicated by a Bowie/Dick test, conducted in accordance with the procedure given in Appendix 6. **It is essential to perform this test at least once every day on each porous load sterilizer in use.**

67. The Bowie/Dick test is a test for rapid penetration of steam into the load. It is not suitable for use on any form of downward displacement sterilizer. Staff required to conduct the test must understand the principle upon which it is based and be adequately trained in its performance.

(ii) Leak test

68. The hospital engineer or other authorized person should carry out a leak test at least once a week and more frequently if necessary, on porous load sterilizers. He should also carry out such a test:

(i) After an overhaul.
(ii) After any maintenance work has been performed on the door, door seals, pipework, valves or other connections to the chamber.
(iii) When the controls indicate failure to sterilize.
(iv) When the presence of air is indicated by the Bowie/Dick test.

Machines should be modified if necessary so that the leak test can be conveniently performed.

(iii) Sensitivity of air detector on porous load sterilizers

69. An amendment to B.S. 3970, Part 1, is in course of preparation. This amendment will require that every sterilizer otherwise conforming to the Standard must be fitted with an air detecting device. The amendment will include a test of the sensitivity of the air detecting device itself. It is hoped to issue an addendum to this Technical Memorandum when the amendment to the Standard is published.

(iv) Routine tests on other sterilizers

70. Routine tests on sterilizers for bottled fluids and sterilizers for unwrapped instruments and unwrapped utensils should be carried out by the hospital engineer or other authorized person weekly or as may be indicated by experience. These tests should be on the lines of those given in Appendices 3 and 4 respectively.

71. The use of spore papers for routine testing of steam sterilizers is not recommended.

X. Procedure for dealing with defective sterilizers

72. If the daily Bowie/Dick test indicates that a porous load sterilizer is not functioning efficiently the machine should at once be taken out of commission and this should be reported immediately by the superintending staff to the hospital engineer or other designated officer. Breakdowns which affect the hospital service should also be reported to the appropriate medical and administrative authorities.

73. Failures in the performance of sterilizers for bottled fluids and sterilizers for unwrapped instruments

and unwrapped utensils should also be reported in the same manner.

74. It is the responsibility of the hospital engineer or other designated officer to ensure that the faulty sterilizer is repaired. The engineer or designated officer should record in the sterilizer log book for each sterilizer a brief outline of the faults reported, the repairs carried out and the time during which the sterilizer was unserviceable.

75. After repairs to a porous load sterilizer the machine should not be brought back into use again until a satisfactory leak test has been completed and a satisfactory Bowie/Dick test has been carried out. After repairs to a bottled fluids sterilizer or to a sterilizer for unwrapped instruments the machine should not be brought back into use again until a satisfactory test, as in Appendix 3 or Appendix 4, has been passed and approval has been given by the hospital engineer or other authorized person.

XI. Maintenance and operating policy and procedure

(i) General

76. The closest co-operation between the superintending staff of the sterilizing department and hospital and Group engineers is required to ensure that high standards of testing and maintenance are attained and perpetuated.

77. The responsibilities of the various officers involved in the operation and maintenance of the sterilizers should be clearly defined and allocated. Clear instructions should be issued on the procedure to be carried out in the event of malfunction, breakdown or accident.

(ii) Reporting faults

78. Any change from normal, observed in the automatic process, must be reported to the superintendent immediately. Any difficulties with the door or its closing mechanism must be reported to the superintendent and the engineer immediately and the machine should not be used again until the defect has been remedied. Failure to observe this procedure has resulted in serious accidents.

(iii) Recorder charts

79. Recorder charts should be checked by the staff of the sterilizing department after each load has been sterilized. Charts should be examined at the end of each day by the superintendent. The engineer should examine them before each weekly maintenance schedule is carried out. The charts should be filed and kept as records for one year.

(iv) Log book

80. A log book should be kept for each sterilizer by the Superintendent or other person deputed for this duty. Each irregularity in performance or operation should be entered in it and reported to the engineer by the operating staff as soon as it is discovered. A record of the date and time at which the report was given should be added. The engineer should enter in the log book the details of repairs carried out and the time the sterilizer was unserviceable. On completion of repairs he should also certify that it is serviceable.

81. It is often found that complaints about performance arise because a known fault has not been reported to the engineer.

82. An entry should be made in the log book, giving the date, time, nature and result of each routine test carried out on the sterilizer. The entry should bear a cross reference to the relevant record chart or Bowie/Dick tape and the signature of the person who carried out the test.

(v) Routine cleaning and preparation

83. It should be the routine duty of staff in the sterilizing department to carry out the following tasks:

(i) Each day the interior of the chamber, including trays and shelves, should be wiped down with a clean damp cloth. Cleaning is especially important for bottled fluids sterilizers dealing with saline solutions. The use of abrasives or cleaning materials which leave deposits must be avoided. A mild detergent may sometimes be used, followed by a clean water rinse. A detergent cleaning procedure must not be adopted on bottled fluids sterilizers having rapid coolers of the "condensate-collecting" type. On such machines the chamber, etc., should be wiped down and cleaned in accordance with the manufacturer's instructions.

(ii) The strainer in the opening to the chamber discharge line should be cleaned daily, or more often if necessary.

(iii) The door seal should be wiped clean each day with a damp cloth and inspected for damage.

(iv) Steam, water and compressed air supply valves should be shut and re-opened just short of full limit, before work starts each day.

(v) The readings on all gauges should be checked and recorded in the log book at the commencement of each working day. Any deviation from normal should be reported and investigated before work starts.

(vi) The cycle counter reading should be entered in the log book at the commencement of each working day.

XII. Planned preventive maintenance (P.P.M.)

84. Sterilizing equipment should be subjected to planned preventive maintenance under the responsibility of a designated officer, irrespective of whether or not a fully planned preventive maintenance scheme is being implemented in the hospital generally.

85. For new sterilizers the P.P.M. programme supplied by the manufacturers should be used (see para. 25). Appendix 7 details a programme which may be applied to existing sterilizers and this should be modified as necessary after taking the particular manufacturer's advice in each case. This programme will not necessarily be suitable if the number of operating cycles differs greatly from those performed in a C.S.S.D. operated on a single shift basis.

86. Although certain inspection and maintenance is required to be carried out by the manufacturer under his guarantee, it is essential that the P.P.M. programme be carried out by engineering staff at all times, including the guarantee period, unless otherwise stipulated in the contract. The hospital engineer or designated officer must also implement any further reasonable instructions given by the manufacturer during the period of the guarantee. Failure to do this may involve the manufacturer in additional expense for which he may seek reimbursement.

87. Common faults, or repeated failure of specific components, should be reported to the sterilizer manufacturer, in order that he may take action in current and future production as well as dealing with the particular trouble reported.

88. The hospital engineer should be fully conversant with the functions of the sterilizers so that, notwithstanding any servicing contract, emergency maintenance can be effected by him if necessary. In the event of any major breakdown the manufacturer should be called in.

Appendix I

Steam quality

General

1. For efficient performance, porous load sterilizers require a constant supply of steam at 50/60 p.s.i.g. with a dryness fraction of not less than 0·95 but not superheated. The quality of steam entering the sterilizer chamber should be checked during the commissioning of a new machine and if complaints of wet loads are made.

2. Trouble with steam quality would not normally be expected provided all steam mains and pipes are properly drained, trapped and effectively lagged and provided the boiler plant is of suitable design and correctly operated.

Contributory causes of wet steam

3. Some causes of the entry of wet steam into the chamber and some notes thereon are given in the table below:

Causes	*Notes*
(i) Defective and/or inefficient thermal insulation of the pipe-work between the boiler and the sterilizer chamber.	(i) The mains, branch connections leading to the sterilizer and pipe-work on the machine must all be effectively lagged.
(ii) Inadequate steam trapping and separating on the supply line.	(ii) Steam separators will not remove all entrained particles of water. The separator and reducing valve must be close to the point of entry of the steam into the sterilizer. The steam trap from the separator should be preceded by a strainer. A non-return valve should be located in the condensate return line after the jacket steam trap.
(iii) Connection to a " dead " steam line.	(iii) The sterilizer should be connected to a live steam main. Long branch connections should be avoided.
(iv) Incorrect inclination of the steam main.	(iv) The steam supply pipe-work between the mains connection and final separator should be inclined downwards towards the separator, for drainage into the trap. Additional drain points and traps may be required, depending upon the pipe arrangement. In the periods when the sterilizer is not in operation, the accumulation of water must be avoided in any part of the pipe-work and fittings between the mains take-off and the sterilizer chamber. This can be achieved by correct inclination of each portion of pipe-work and by adequate trapping.
(v) Incorrect method of tapping the steam main.	(v) The steam supply to the sterilizer should be taken from the top of the mains pipe.
(vi) Priming or carry-over of the boiler.	(vi) This may be caused by: (*a*) incorrect feed-water treatment; (*b*) forcing a boiler which needs internal cleaning; (*c*) violent boiling under fluctuating load conditions (especially with high water levels); (*d*) absence of an internal steam pipe or collector or by the incorrect fitting or defective design of this member. Modern compact and highly rated boilers are particularly sensitive to feed-water treatment and are much more likely to prime than boilers of traditional design.
(vii) Foaming and carry-over.	(vii) Over-dosing of feed-water treatment may result in foaming and carry-over. The removal of the anti-priming pipe can sometimes lead to improvement under certain conditions of foaming. In bad cases the addition of an anti-foaming agent can collapse the foam layer for a period of 24 hours.
(viii) Improper water treatment.	(viii) Many wet steam problems are associated more with the composition of boiler water than with operating conditions. Careful control of water treatment and blow-down procedures is essential.

Superheated steam

4. At 32 LBF/IN^2 the temperature of dry saturated steam is 136°C (276·7°F). If at this pressure the chamber temperature is above 136°C the steam in the chamber is superheated. Superheated steam is not suitable for sterilizing.

5. The usual cause of superheating is an excessive reduction of steam pressure through the reducing valve. This is unlikely to occur under the conditions normally met in most steam systems but may be encountered if the high pressure steam is unusually dry or is at an unusually high pressure.

6. When such superheating occurs it can often be overcome by either or both:

(i) Moving the final pressure reducing valve so that it is further away from the sterilizer (by several feet at least).

(ii) Installing another reducing valve in the steam main at a distance from the sterilizer to lower the supply pressure so that the final pressure reduction at the sterilizer is not so great.

7. Superheating of the chamber steam is also likely to occur if the pressure in the jacket is higher than that in the chamber.

Appendix II

Notes on Clauses of various Parts of British Standard 3970 : 1966

Part 1. Sterilizers for porous loads

Clause	Action required in general and particular specifications
3	Appropriate nominal capacity to be stated.
4	It is not usually satisfactory to give the working height as indicated in the Standard where the sterilizer is for use in a C.S.S.D. (or T.S.S.U.). In this case the critical height is usually the top of the loading rails in the chamber and this, in turn, is the corresponding height on the loading carriage. This point is of particular importance when a sterilizer is required for addition to an existing installation.
5	State whether to be free standing or for building in.
6	State, from tables given, materials to be used in jacket and chamber. If any of tabulated combinations is acceptable, say so.
7(g)	(i) State whether door to be at one end or both ends. (ii) If a hinged door is preferred or acceptable state whether hinge should be on right or left when looking at the door; or whether this is immaterial. (iii) If sliding door is acceptable state whether, if it moves to one side, it must open to right or left or if this is immaterial.
8	Contractor to be advised that **leak test** position is required on controls.
9	Some manufacturers pass the chamber steam through the jacket with the objects of: (*a*) meeting the requirement of a separator on the low pressure side of the reducing valve; (*b*) minimizing the risk of admitting superheated steam to the chamber. Such an arrangement is usually satisfactory. *Note:* This Technical Memorandum recommends the provision of a separator on the high pressure side of the reducing valve. This is additional to the B.S. requirement.
10	B.S. 3790, Part 1, 1966 is being amended to read as follows: " 10 (b) ***Stage 2 sterilization*** Steam shall be admitted to provide sterilizing conditions within the chamber load. The sterilizing conditions shall be such that, when the chamber is loaded in accordance with the test requirements of Sub-Clauses 25(a) and 25(b) the temperature of 134+4−0°C is maintained in the test casket for not less than three minutes within a total time for Stage 2 of six minutes. Provision may be made for alternative time—temperature relationships, in addition to the sterilizing conditions specified, if required by the purchaser. . . ." ***The view of the Ministry is that an alternative time-temperature relationship is not usually necessary or desirable and indeed can complicate the supervision and maintenance problems.***
14	(i) The manufacturer should be invited to state how the accuracy of the indicating thermometer and recording thermometer may be checked under operating conditions without disturbing them. Thermometer pockets should be provided for this purpose if necessary. (ii) The provision of a recording thermometer is recommended in this Technical Memorandum and the manufacturer should be required to provide one.
19	The requirements for internal shelves and for loading carriages, etc., should be stated.
25	B.S. 3790, Part 1, 1966 is being further amended to include provision of an air detecting device and means for testing it.
	Part 2. Sterilizers for bottled fluids
3	Appropriate internal dimensions to be stated.
4	It is not usually satisfactory to give the working height as indicated in the standard where the sterilizer is for use in a C.S.S.D. In this case the critical height is usually the top of the loading rails in the chamber and this, in turn, is the corresponding height on the loading carriage. This point is of particular importance when a sterilizer is required for addition to an existing installation.
5	State whether to be free standing or for building in.
6	State whether chamber is to be constructed from nickel-clad steel or from stainless steel or whether either or both may be offered.
7(e)	(i) State whether a door to be at one end or each end. (ii) If a hinged door is preferred or acceptable state whether hinge should be on right or left when looking at the door or whether this is immaterial. (iii) If a sliding door is acceptable state whether, if it moves to one side, it must open to right or left or if this is immaterial.

Clause	Action required in general and particular specifications
10	(i) Some manufacturers control and indicate the temperatures from within one or more bottles, not within the chamber drain as stated in the Standard. This is acceptable. (ii) State the time/temperature relationship required. (iii) State whether accelerated cooling is required. If accelerating cooling is needed the manufacturer should be required to state whether a water softener must be provided for it. (iv) State whether means are required for maintaining equilibrium pressure (air ballasting).
13	(i) The manufacturer should be invited to state how the accuracy of the indicating thermometer and recording thermometer may be checked under ***operating*** conditions without disturbing them. Thermometer pockets should be provided for this purpose if necessary.
16	Manufacturers should be advised that means should be provided for the attachment of the purchaser's test gauge.
18	The requirements for internal shelves and for loading carriages should be stated.
	Part 3. Sterilizers for unwrapped instruments and unwrapped utensils (Ref. is to the Draft B.S. 3970, Part 3, dated November 23, 1965)
4	(i) State whether door to be at one or both ends. There is seldom a good reason for the provision of a door at each end. (ii) If a hinged door is preferred or acceptable state whether hinge should be on right or left when looking at the door, or whether this is immaterial. (iii) If a sliding door is acceptable state whether, if it moves to one side, it must open to right or left or if this is immaterial.
6	The requirements for trays and/or basket should be stated.
7	State whether to be free standing or for building in.
8	The manufacturer should be invited to state how the accuracy of the indicating thermometer may be checked under operating conditions without disturbing it. A thermometer pocket should be provided for this purpose if necessary.
10	The manufacturer should be advised that means should be provided for the attachment of the purchaser's test gauge.

Appendix III

Tests for Sterilizers for Bottled Fluids

Scope of tests

1. The test shall be carried out on each sterilizer with a full load of the largest type of bottle for which the machine is designed.

Temperature (°C)	*Time* (min.)
115+1−0	30
121+2−0	15

Preparation for test

2. For the purpose of the tests the temperature in the chamber drain and the temperature from within nine bottles identical with those comprising the load shall be recorded. These bottles shall be situated at all corners and the centre of the load. If there are two layers the centre bottle shall be the one in the lower layer.

Sterilizing temperature

3. The sterilizing temperature of the fluids shall be one of the two temperatures given below and shall be maintained for the period specified.

Method of test

4. The sterilizer shall satisfactorily perform the complete sterilizing cycle (which shall include air ballasting and rapid cooling if these are provided) and this performance must be under automatic control. The sterilizer shall be considered as having passed the test if, on all tests:

(i) The temperature recording shows that the fluid in the lowest inch of all test bottles has attained or exceeded one of the temperatures specified and has maintained this throughout the corresponding specified period.
(ii) The monitoring bottles have not broken.
(iii) Not more than 1 in 100 of the bottles has broken.

Appendix IV

Test for Sterilizers for Unwrapped Instruments and Unwrapped Utensils

The sterilizer, having been properly loaded with a full load of instruments and bowls of the type normally processed in the machine, shall perform a complete sterilizing cycle under automatic control. It shall be considered as having passed the test if the following conditions are met:

(i) The temperature in the chamber drain shall have reached 134°C+4°C−0°C, and this temperature shall have been maintained for not less than three minutes, the thermometer having been checked by the use of a thermocouple recorder of accuracy plus or minus 0·5°C.
(ii) The whole cycle shall have been completed in not more than 10 minutes.

Appendix V

Planning Information

1. Information given in this Appendix is intended as a general guide for initial planning purposes. There are wide variations between the actual dimensions, weights and service requirements of different makes of sterilizer. Before detailed planning is undertaken, the actual requirements of the machines to be installed should be established.

2. The provision of adequate clearance around machines giving access for maintenance is essential. Although some manufacturers may claim that smaller clearances are permissible, it is recommended that the following minimum clearances should be provided in all cases:

(i) 3 ft. around all parts to which access for routine maintenance is necessary.

(ii) 2 ft. around all other parts.

3. Particular care should be taken to ensure that sufficient clearance is allowed for large items such as vacuum pumps to be withdrawn from the sterilizer frames.

4. Attention is drawn to the need for adequate ventilation of the area near the sterilizers to remove the heat emitted.

Minimum planning dimensions

The following notes refer to Fig. 1 and Table 1 below:

(i) Dimension B does not include the projecting parts associated with sideways sliding doors. In most cases such projections are confined to the front end of the machine and can be accommodated within the recommended dimension A without impeding access for maintenance.

(ii) Dimension F may be the same as dimension C if ancillary equipment mounted between sterilizers is relatively short. If such equipment is long enough to restrict the access for maintenance of the sterilizers, dimension F should be the same as dimension A.

(iii) The minimum working height required for maintenance is 8 ft.

(iv) The dimensions quoted are also applicable to free standing units if allowance is made for the casing.

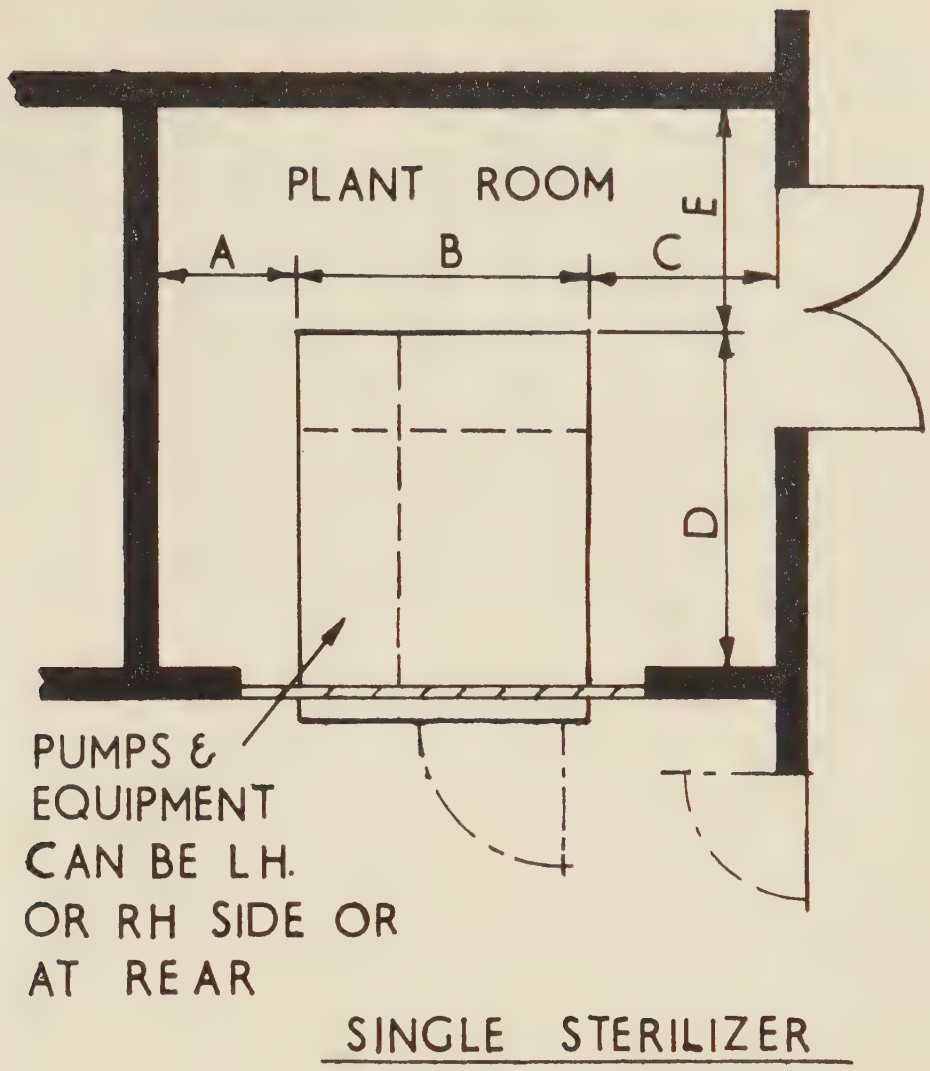
(v) Extra allowance must be made for built-in or free standing steam generators, when these have to be provided in addition.

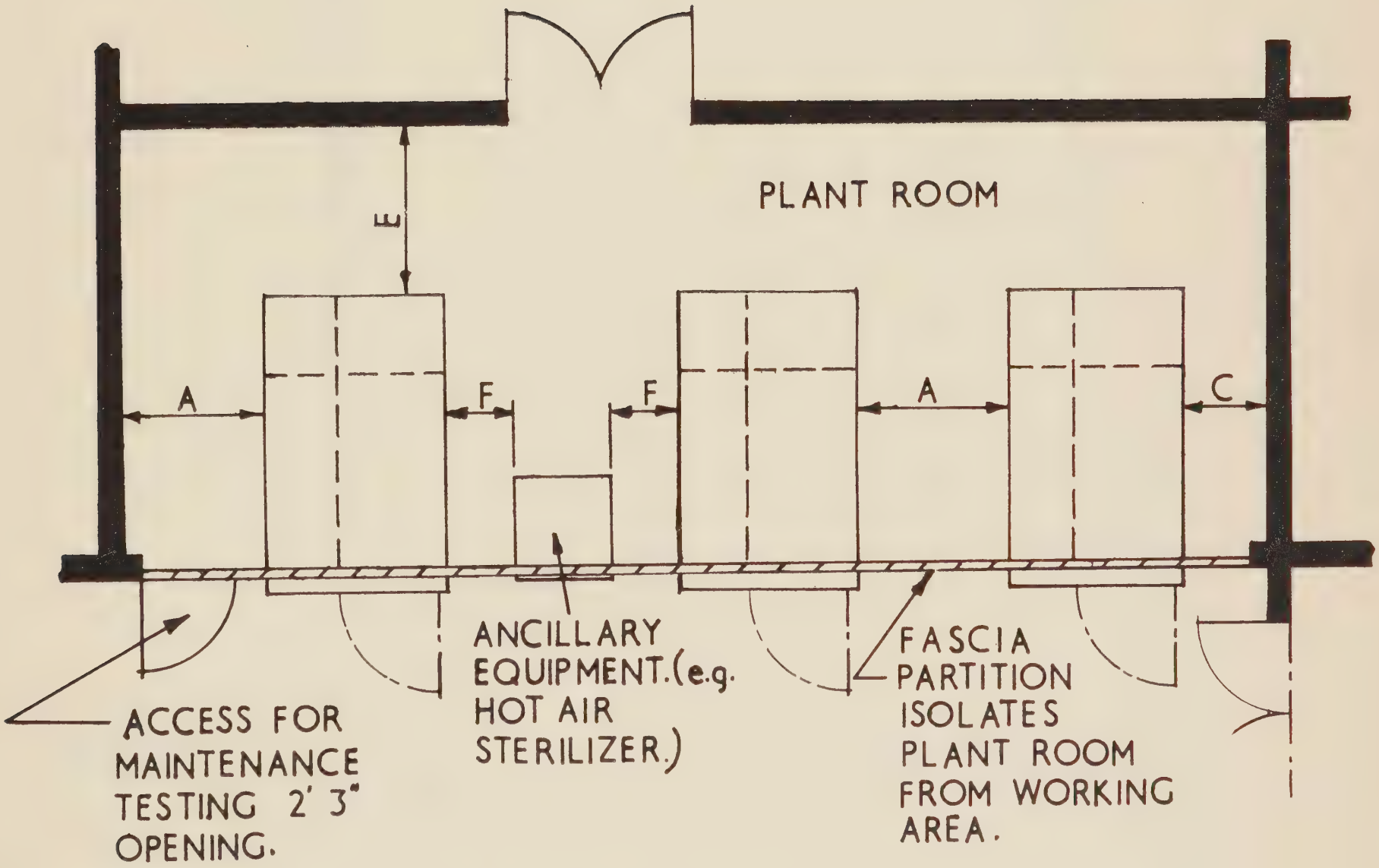
(vi) Spacing should be such that it is possible to replace any sterilizer without disturbing others in the same installation. In some cases this will entail an increase in dimension E.

(vii) The building and room access doors should be of a type and size which will permit passage of the equipment.

(viii) A single door will be required in the front panel if there is no other direct route between the plant room and the front of the sterilizer(s).

FIG. 1. Horizontal Chamber Sterilizer



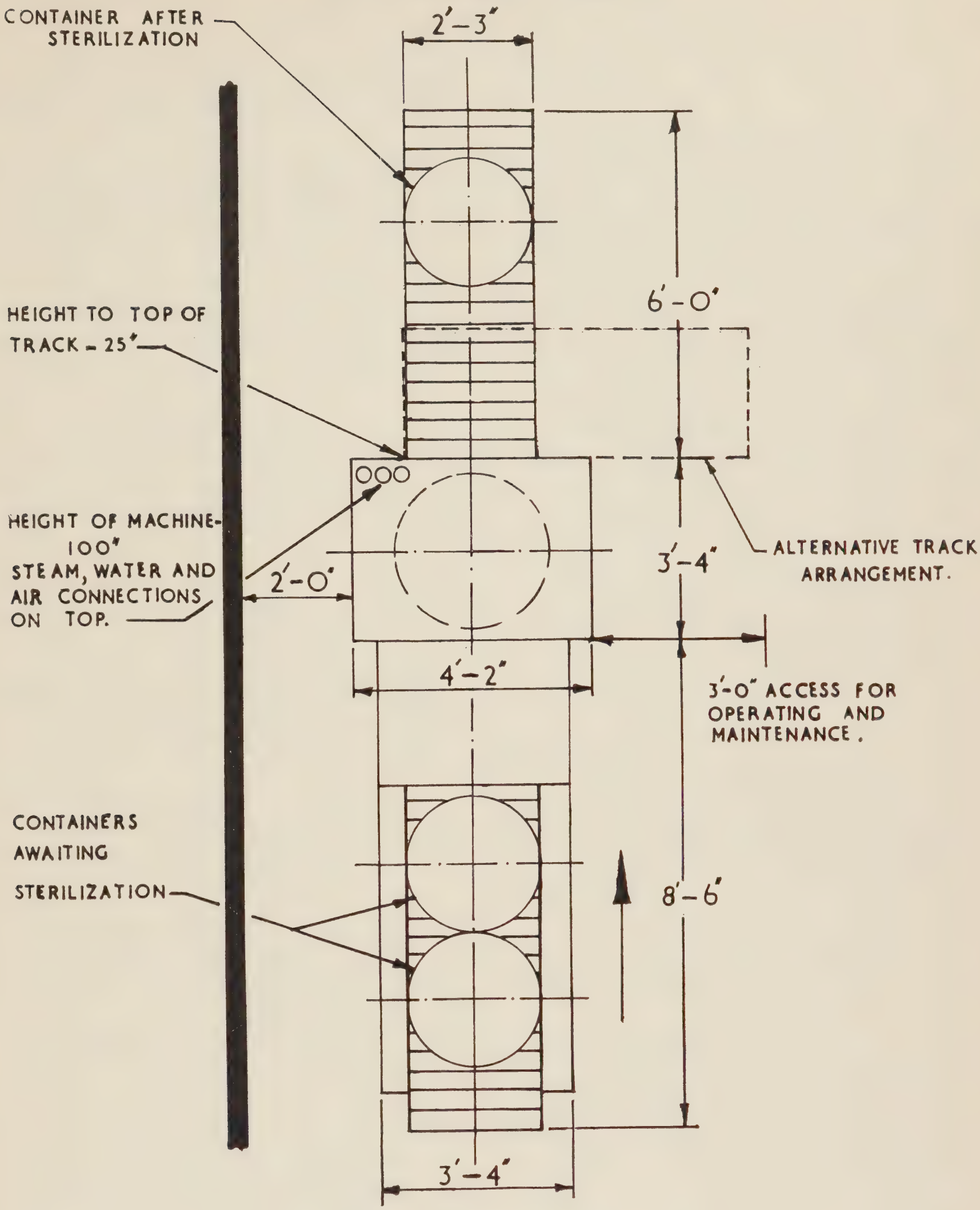


APPENDIX V Table 1

Minimum Planning Dimensions

Type	Size (inches) H.W.L.	Nominal capacity (cu. ft.)	Dimensions in feet and inches (see Fig. 1)						Weight
			A	B	C	D	E	Height	
Porous loads, to B.S. 3970, Part 1	18 dia. × 30	4·5	3·0	3·0	2·0	5·0	3·0	6·0	15 cwt.
	26 × 26 × 26	10	3·0	4·0	2·0	5·6	3·0	6·6	1–2 tons
	36 × 26 × 26	14	3·0	4·0	2·0	5·6	3·0	6·6	
	36 × 26 × 39	21	3·0	4·0	2·0	6·6	3·6	6·6	
Bottled fluids to B.S. 3970, Part 2	36 × 26 × 26	14	3·0	4·0	2·0	6·0	3·0	6·6	1–2 tons
	36 × 26 × 39	21	3·0	4·0	2·0	7·0	3·6	6·6	
	36 × 26 × 52	28	3·0	4·0	2·0	8·3	3·6	6·6	
Unwrapped instruments and unwrapped utensils to B.S. 3970, Part 3	12 dia. × 20	1·3	3·0	2·3	2·0	3·0	3·0	5·3	6 cwt.

Fig. 2. Vertical chamber sterilizer.



CHAMBER
26" DIA. X 30" NOMINAL CAPACITY
10 CU. FT.

CONTAINERS
23" DIA. X 30"

TRACK LENGTHS AND ARRANGEMENTS CAN BE SUPPLIED TO SUIT LOCAL CONDITIONS.

APPENDIX V Table 2

Approximate service connection sizes and demands

	Chamber size		Steam					Condensate			Water		Power		
					Consumption				Drain				Motors		
	Dimensions and inches H.W.L.	Nominal capacity cu. ft.	Inlet size in.	Max. flow lb/hr.	lb/cycle	lb/hr.	Safety valve vent size in.	Return size in.	Size in.	Max. flow g.p.m.	Inlet size in.	Flow g.p.m.	Door (a) H.P.	Pump H.P.	Total electrical load K.W.
Porous load to B.S. 3970, Part 1														*Vacuum*	
	18 dia. × 30	4·5	¾	250	20	70	1	½	1½	4	¾	4	—	2	2
	26 dia. × 30	(c) 10	¾	400	30	120	1	½	1½	5	½	5	(d)	7½	9
	26 × 26 × 26	10	1	400	40	90	1	¾	1½	5	¾	4	½	2	3
	36 × 26 × 26	14	1	400	45	100	1	¾	1½	5	¾	4	½	2	3
	36 × 26 × 39	21	1	450	60	110	1¼	¾	2	5	¾	5	½	4	6
														Water (b)	
Bottled fluids to B.S. 3970, Part 2	36 × 26 × 26	14	¾	300	80	75	1	¾	1½	5	¾	4	½	1½	3
	36 × 26 × 39	21	¾	350	120	110	1¼	¾	1½	5	¾	4	½	1½	3
	36 × 26 × 52	28	¾	400	160	130	1¼	¾	1½	5	¾	4	½	1½	3
Unwrapped instruments and unwrapped utensils to B.S. 3970, Part 3	12 dia. × 20	1·3	½	200	5	40	½	½	1¼	3	½	4	—	—	1

(*a*) When power operated. (*c*) All figures relate to vertical chamber machine.
(*b*) For rapid cooling. (*d*) Requires piped supply of compressed air.

Water supply. A pressure of 20 p.s.i. or above is usually required. It is sometimes necessary to fit a boost pump and/or break tank to ensure that a satisfactory pressure is maintained at all times.

Electricity supply. Most porous load and bottled fluids machines require a three-phase, four-wire supply at 415 V, 50 c.p.s. Machines for unwrapped instruments and utensils require a single-phase 240 V, 50 c.p.s. supply. Machines can be supplied to operate on other supplies, to special order.

Appendix VI

The Bowie/Dick tape test for porous load sterilizers

The need

1. Modern porous load sterilizers can cut the time needed for a complete run from an hour or more to as little as 15 minutes.

2. This is possible because steam will penetrate porous loads virtually instantaneously if all the air has previously been removed from the chamber and from the load.

3. If the air is not removed, either because the pump is not working properly or because air has leaked in through faulty door-seals or valves, steam can only penetrate the load slowly and inadequately and unsterile loads may result.

4. All new sterilizers have a built-in safeguard which stops the cycle if the air is not properly removed, but even this mechanism may fail. Other sterilizers may seem to be satisfactory although they are, in fact, quite unsafe. Daily testing is therefore necessary on all high-vacuum sterilizers.

5. The performance of sterilizers can be tested by using expensive and complicated electrical equipment, and this should certainly be done during commissioning of new sterilizers. Such test equipment is often not readily available and there is a need for a simple but reliable day-to-day test which requires no special apparatus and which is quick and easy to carry out.

The solution

6. The Bowie/Dick tape test is designed to meet this need. The description that follows is based on an article in *The Lancet* and has been prepared after consultation with the authors.*

7. The principle is very simple. A standard test pack is made up from huckaback towels. In the centre is placed a piece of paper to which has been fixed a cross of M.M.M. No. 1222 Autoclave tape, such as is widely used for sealing bundles and indicating that they have been subjected to a steam sterilizing process. This tape will show a colour change related to time and temperature when exposed to steam. The test pack is placed alone in the chamber and autoclaved in the usual way. **If all the air is removed** the steam will penetrate rapidly and completely and the tape will show a uniform colour change. **If all the air is not removed,** when steam is admitted for the sterilizing stage the air will be forced into the centre of the pack, where it will collect as a " bubble ". The colour of the tape in the region of the " bubble " will be paler than elsewhere along its length because of lower temperature and this will show up when the paper with the tape cross is removed at the end of the run.

8. Figure 1 shows how the test is set up; Figs. 2 and 3 show the difference between the appearance of a good and bad result.

9. If the test is to be a reliable guide to the safe working of the sterilizer it must be carried out **exactly** as described.

Important

Unless the test is carried out **exactly as described** it may not be truly reliable. In particular the following points should be noted:

(i) The more air there is to remove, the more exacting will be the test—that is why the test pack is used by itself in an otherwise empty chamber.

(ii) The exact colour change shown by the processed tape may depend on the storage conditions. The important thing is whether the **same colour change** occurs at the centre and the edges.

(iii) The contrast in colour change from centre to edge will be reduced to an unreadable level if long " holding " periods are used. That is why **the holding period must not exceed 3½ minutes at 134°C.** Even an extra minute or two may seriously affect a comparison of results.

(iv) **Because of this it is important to realize that if a sterilizer fails to pass the Bowie/Dick test as described, it cannot be made safe merely by increasing the holding time until a uniform colour change is produced. Such a sterilizer is in urgent need of skilled attention.**

What is needed for the test

10. **Towels**—Up to 36 huckaback towels, 36 in. by 24 in., complying with B.S.S. 1781.TL.5. The towels should be washed before being used for the first time and whenever they are soiled or discoloured: between tests they should be unfolded and hung out to air for at least an hour.

11. **Tape**—The only tape which the authors found satisfactory was M.M.M. brand Autoclave Tape No. 1222.

Making up the test pack

12. Each towel should be folded into eight thicknesses and placed one above the other to form a stack 10–11 in. high (Fig. 1). The exact number of towels needed will depend on how often they have been used, but 25–36 may be needed. A piece of paper to which autoclave tape has been applied in the form of a St. Andrew's cross is placed in the middle of the stack—greaseproofed or waxed paper should not be used. The stack may be placed in a dressing casket (such as that described in B.S. 3281) or in a box made of cardboard or metal, which is not airtight. If preferred, the stack can be wrapped in fabric or paper, or it can be secured with tape. Whichever method is used the towels must stay in position when the test pack is handled. The towels must be laid quite flat in the casket, with no ridges.

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* Bowie, J. H., Kelsey, J. C., Thompson, G. R. (1963). The Bowie and Dick Autoclave Tape Test. *Lancet*, i, 586.

Fig. 1. General arrangement for test, showing towels and tape before test.

Performing the test

13. The test pack must be placed in the sterilizer **by itself, with the towels lying horizontally,** and be subjected to a standard sterilizing cycle. **The " holding " or " sterilizing " time must not be more than 3½ minutes** if a temperature of 134°C (273°F) is being used.

14. The test should normally be carried out under automatic control but if the automatic control is set for a longer holding time than 3½ minutes the stage must be cut short, for the purposes of the test, by using the manual control. Should there be any doubt about how to do this the engineer should be asked for advice.

Reading the test

15. When the cycle is finished the pack should be taken out and the paper with the tape cross should be examined.

16. After a satisfactory run the tape will show a colour change **which is the same at the centre as at the edges** (Fig. 2).

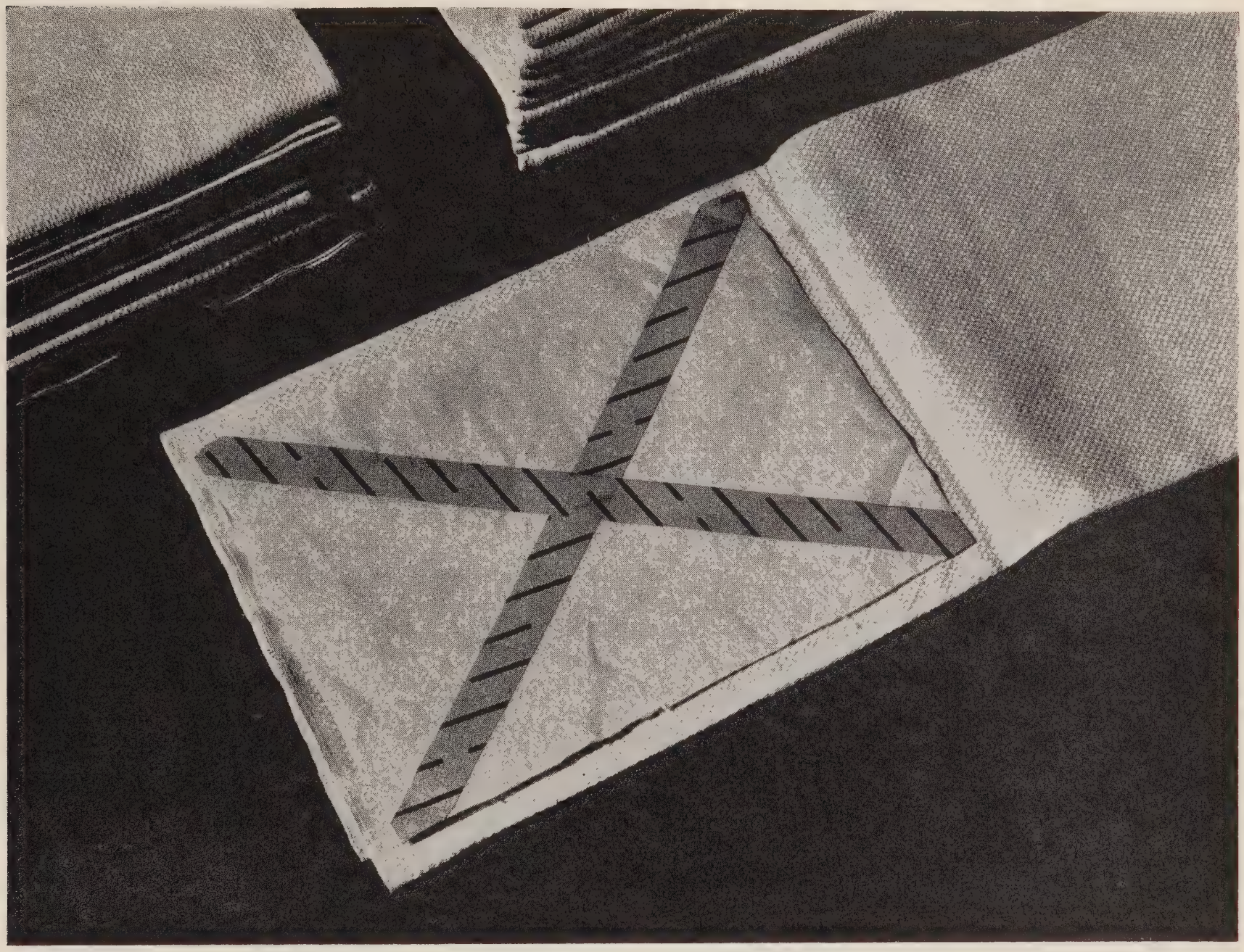

Fig. 2. Satisfactory run (uniform colour change).

17. If the tape at the centre is paler than it is at the edges it indicates the presence of air at the centre and that the sterilizer is not working properly (Fig. 3). If this happens the matter should be reported at once.

18. The paper with its tape cross from each test should be marked with the date and other particulars and kept for reference together with the associated chart from the recorder.

19. The towels should be aired and folded ready for the next test.

Note: This test is not suitable for use for any form of downward displacement sterilizer. It is valid for high-vacuum machines.

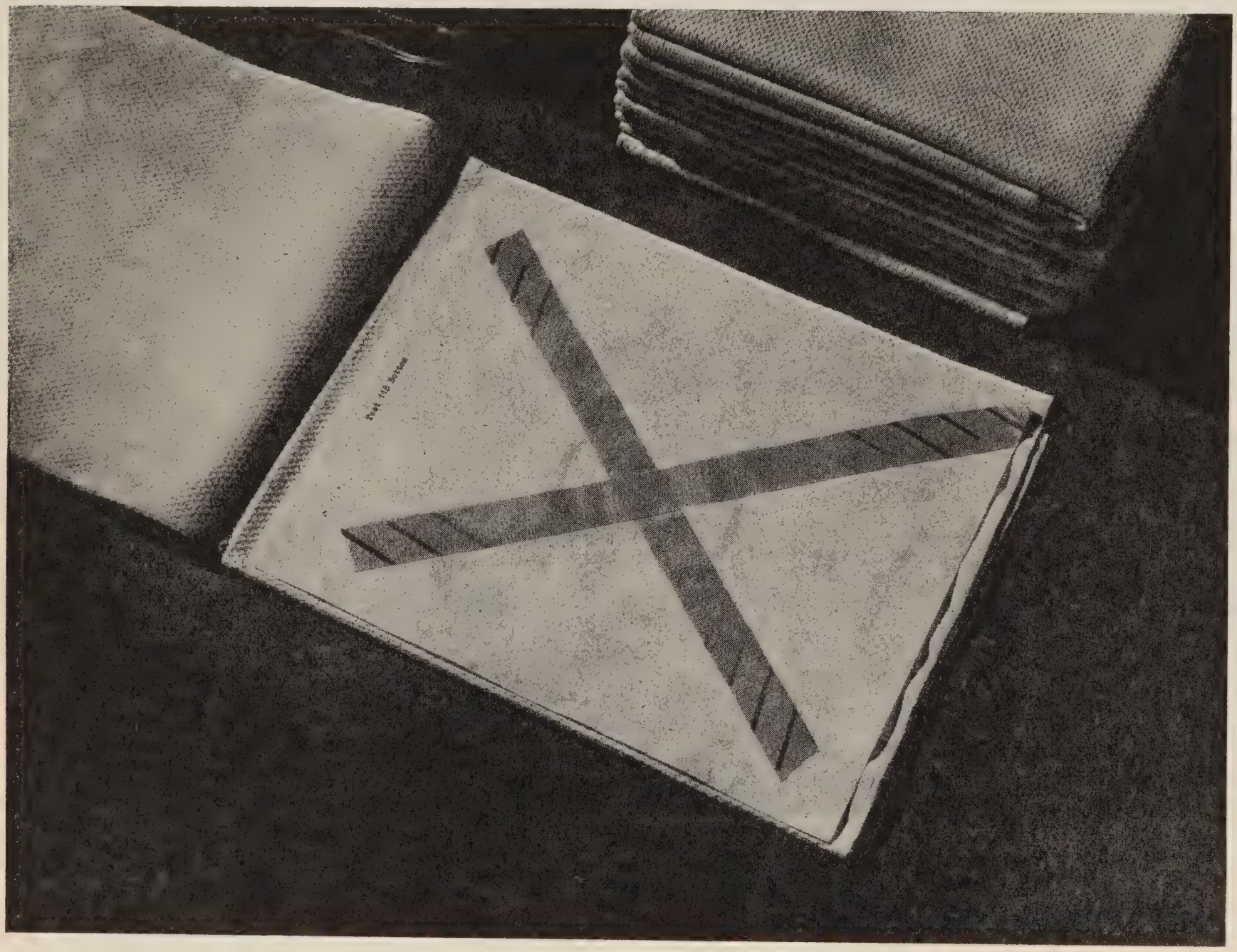

Fig. 3. Unsatisfactory run (colour change incomplete at centre).

Appendix VII

Planned Maintenance Programme for Steam Sterilizers

General

1. It is very important that staff allocated to maintenance of sterilizers have a good knowledge of the design and function of these machines and are thoroughly instructed in the features of the particular manufacturers' models installed in their hospital. Such instruction is usually best obtained from the makers, often by courses at their works.

2. No indication is given in this Technical Memorandum of the immediate action to be taken if implementation of the programme brings faults to light. Hospitals should therefore issue appropriate instructions to staff on this matter.

3. The programme given in this Appendix is intended as a general basic guide. Some of the points mentioned will not be applicable in all cases.

4. Before commencing the Weekly Tasks the engineer will satisfy himself that the Daily Tasks have been carried out by the operator on the lines indicated in para. 83 of this Technical Memorandum. If he is not satisfied in this respect he will record his dissatisfaction in detail in the log book and draw the attention of the " sterilizing superintendent " to the matter.

5. For the purposes of the programme the definitions are the same as those used in the manuals accompanying Technical Memorandum No. 13, *Planned Preventive Maintenance* (Mechanical Manual PM.G/13 and Electrical Manual PM.G/12). These are:

Examine. To make a visual examination without dismantling in order to verify that the plant or equipment is in efficient and safe working order.

Test. To operate the plant or equipment and/or use the appropriate testing instruments to ensure that plant or equipment is functioning correctly.

Check. To make a thorough inspection for damage and wear, also to ascertain that the plant or equipment is properly adjusted to conform to the correct standards.

Frequency periods

6. The frequency periods given correspond with those laid down in the above manuals, PM.G/13 and PM.G/12.

7. Practical experience with components of sterilizers of different manufacturers might well result in the need to vary some frequencies in particular installations.

Overhauls

8. In addition to the examinations, tests and checks set out in the programme, every two years the group engineer should arrange for a general overhaul of all sterilizers and components. Overhauls of machines must not coincide. Arrangements should be made for shedding the work-load if need for stand-by capacity arises during overhaul. It would not normally be necessary to provide a temporary machine.

Temperature recorders

9. Whilst it is working correctly it is preferable not to interfere with a recorder more than is absolutely necessary. The instructions of the manufacturers in respect of operation and adjustment must be strictly adhered to. Maintenance of these instruments demands specialized attention and is best undertaken by the manufacturer.

10. The case should never be left open and broken glass should be replaced promptly.

11. Only persons who have received proper instruction and appreciate the delicate nature of the instruments should be allowed to change the charts.

12. A recorder should be regarded as a valuable instrument to indicate the general functioning of the sterilizer, but temperatures read from it must be regarded with caution and interpreted only in the light of previous records or previous tests. Temperature sensing and measuring instruments (especially recorders) are subject both to inherent calibration errors and to loss of calibration with use.

Steam generation equipment

13. Steam raising equipment, either manufactured as an integral part of the sterilizer or provided separately, is not included in the following programme.

Accuracy of gauges

14. Every three months, or more frequently if so desired, the accuracy of the gauges and thermometers should be ascertained by the hospital engineer. Replacement gauges, set and tested by the makers, should be kept in store.

Air-tightness of the chamber

15. The effectiveness of the door seal is the chief factor in the air-tightness of the chamber as a whole, and it must receive particularly careful attention. The recommended working life of door seals varies widely, but it is essential that all seals are renewed regularly at the intervals recommended by the manufacturers.

16. Seals must also be renewed when there is any evidence of damage or deterioration.

17. Every week, or more frequently if necessary, the air-tightness of the chamber when under reduced pressure should be tested under the supervision of the hospital engineer.

18. This is usually done at the end of a vacuum-drawing stage, by turning a key-operated switch to the **leak test** position, to close all automatic valves connected to the chamber and to stop the vacuum pump. In some cases it may also be necessary to ensure that certain hand-operated valves are closed.

19. Considerable care and knowledge must be applied in the interpretation of the results of leak tests. On a typical test the absolute pressure may rise by 20 mm. or more, in the first five minutes of the test, due to the evaporation of moisture remaining in the chamber and connected pipework. **Such a result does not necessarily indicate a leak.** After the initial rise in pressure due to this evaporation the test should be continued for a further period of 10 minutes, and during this further period the rise in absolute pressure should not exceed 20 mm. If there is any doubt about a test result a further test should be undertaken to confirm it.

20. The effect of moisture in the chamber upon the leak test result can be minimized by testing whilst the sterilizer is hot.

21. For the purpose of the test it is not necessary to achieve a chamber pressure lower than that normally required in the operating cycle.

22. The gauge required for this test is referred to at para. 37. Alternatively an accurate manometer may be used.

23. The guidance of the manufacturer should be followed in the conduct of the test.

Air detection devices

24. A leak in an air detection device could be so small that it would be unnoticed by the ordinary leak test. Such a small leakage would have a very serious effect in most machines since it would permit the expulsion by steam of any air present in the device. This would indicate falsely that all air had been removed from the chamber.

25. Great care must be taken when installing, removing or adjusting any part of this device. It is preferable not to interfere with it.

Ancillary equipment

26. Because of the wide variation in design of devices performing similar duties, manufacturers' instructions should be consulted.

27. Where sterilizers incorporate standard items such as air compressors, air receivers, or water softeners, Manual PM.G/13 should be consulted.

Examination of recorder charts

28. A record should be made in the log book for each machine, showing the correct temperature and pressure at the commencement and end of each stage or sub-stage and the time which should elapse for each stage or sub-stage. These entries should relate to given loading conditions, such as test casket or full load as described in the Standard, or as fixed locally. They should all relate to automatic operation.

29. The "sterilizing superintendent" and engineer should jointly examine the charts for each week, compare the recordings with the standards laid down as above, and investigate any abnormality.

Weekly Tasks

Part concerned	Notes
1. Door locking and clamping mechanisms. 2. Drive mechanism on automatic doors.	1 and 2. Test mechanisms. Doors should be sealed before the locking mechanism has reached the end of its travel. Special attention should be given to the depth to which the radial arms penetrate into their locking sockets. Examine door clamps where fitted on automatic doors and adjust as necessary.
3. Chamber door safety devices.	3. Examine condition of diaphragm on door-opening pressure safety locks. Test steam admission interlocks and micro-switches on door closing movement in conjunction with 5 as necessary. The chamber should vent before the locking mechanism is fully released.
4. Chamber door seals.	4. Wipe clean and examine for signs of damage or deterioration. (i) Dress rubber seals with French chalk. (ii) Dress rubber cored asbestos seals with graphite. (iii) Seals of silicone rubber or neoprene should not be dressed.
5. Electrical safety devices.	5. Test all devices; faults should be purposely introduced, if necessary, to perform these tests.
6. Indicating lights and controls.	6. The sterilizer should be run through a complete cycle under automatic control, and under the fixed loading conditions as indicated in the log book for each particular machine. Observe whether each stage or sub-stage of the cycle commences and ends at the correct temperature or pressure and/or takes the correct time, as recommended by the manufacturer. Adjust if necessary.
7. Chamber drain thermometer.	7. Test thermometer against a standard one.
8. Instruments—general.	8. Test. Corresponding thermometers and pressure gauges should be in general agreement.
9. Vacuum pump.	9. Grease bearings as required. Test performance and quiet running. ***Water-sealed pumps.*** Adjustment can be made as required by control of the water flow, to obtain smoothest running coupled with highest vacuum. Failure to secure these by adjustment may necessitate inspection of the interior of the pump for damage by abrasive material. Such damage is unlikely if water and vacuum filters are sound. ***Oil-Sealed pumps.*** The oil level should be examined and water contamination looked for. Any water accumulation should be drained from the pump. If water contamination is excessive the oil should be changed. The pump must not be overfilled with oil, otherwise oil carry-over to the exhaust will occur.
10. Strainers in the pump, vacuum and water lines.	10. To be removed, cleaned and replaced.
11. Steam valve to the chamber. 12. Exhaust unit check valve. 13. Chamber steam trap check valve. 14. Steam heating of vacuum pump.	11, 12, 13, 14. These parts should be examined if the vacuum is poor or there is evidence of emulsification in oil-sealed vacuum pumps.
15. Chamber and cooling system of bottled fluids sterilizers.	15. Flush and clean in accordance with makers' instructions.
16. Water tanks, including condensate vessels.	16. Tanks should be examined for pollution, corrosion, and wear of float valves when fitted.
17. Rapid cooling device.	17. Test performance of spray nozzles.
18. Air filter dust-cover or coarse air filter.	18. To be cleaned or replaced.
19. Chamber travel mechanism (vertical chamber machines).	19. Test mechanism and examine flexible connections.
20. Automatic load feeding mechanisms.	20. Lubricate and test.
21. Air-tightness of chamber.	21. Perform leak test.

Six-Weekly Tasks

Part concerned	Notes
1. Chamber door locking mechanism and hinges.	1. Check and lubricate with a heat-resisting grease as necessary.
2. Automatic door drive and clamping mechanisms, including chamber locking toggles on vertical chamber machines.	2. Clean, lubricate, check and adjust as necessary.
3. Steam safety valves.	3 and 4. The release lever should be eased manually with the valve under pressure to test free operation.
4. Compressed air relief valves.	
5. Reducing valves (steam and compressed air).	5 and 6. Examine all spindles, and gaskets. Clean, especially around springs and moving parts. Examine control and adjusting springs for correct freedom of movement. Test valves and adjust settings as necessary.
6. All spring-loaded valves.	
7. Steam traps.	7. Check.
8. Strainers.	8. Clean and examine all screens for damage. Replace if necessary.
9. Steam separator.	9. Examine and clean.
10. Chamber interior.	10. Examine for foreign matter and for deterioration of surface finish.
11. Chamber drain.	11. Examine and clean.
12. Bolts.	12, 13, 14 and 15. These parts should be examined for tightness. Gaskets and washers should be replaced as necessary.
13. Locking rings and washers.	
14. Unions, and pipe connections.	
15. Stuffing-box glands.	
16. Chain, shaft, gear and cam drives.	16. Clean, examine, lubricate and adjust as necessary.
17. Belt drives.	17. Clean, examine and adjust tension as necessary.
18. Manual controls.	18. Run through process to test.
19. Water pumps.	19. Test, repack gland if necessary.
20. Water pressures (including main supply).	20. Test pressures and record in log book.
21. Air line lubricator.	21. Dismantle and clean and refill.
22. Tundishes and floor gullies.	22. Examine and clean.
23. Loading carriage.	23. Examine wheels, carrier rollers, locking mechanism and alignment with sterilizer.

Quarterly Tasks

Part concerned	Notes
1. Automatic controller—process time unit.	1. A general check of removable components should be carried out.
2. Oil in the vacuum pump.	2. To be changed.
3. Condenser.	3. The coils to be cleaned if accessible.
4. Water and steam ejectors.	4. Clean and examine.
5. Steam valve to chamber.	5. Renew valve seat and disc as necessary.
6. Camshaft valves and tappets.	6. Renew valve seats and discs as necessary. Adjust tappets.
7. Door test cock.	7. Renew seat and disc if necessary.
8. Earthing arrangements of electrical apparatus.	8. Earth continuity should be tested, including exposed metal work.
9. Contacts of motor starters.	9. Examine and adjust as necessary.
10. Oil level in overload dash-pots.	10. Examine and top up as necessary. Ensure overload setting is correct.
11. Rapid cooling device.	11. Clean and test cooling/heating coils. Test thermostats and adjust as necessary.
12. Vacuum switches and pressure switches.	12. Test switches and confirm vacuum/pressure settings. When testing a vacuum switch a barometrically compensated gauge must be used. The gauge on porous load sterilizers may not be barometrically compensated.

Half-Yearly Tasks

Part concerned	Notes
1. Air detection device.	1. Test to be specified after publication of amendment to British Standard.
2. Instruments, gauges and recorders.	2. Test by comparison with accurate standards.
3. Electric motors.	3. Test the insulation of windings and associated wiring. Examine brush gear.
4. Electrical terminals and connections.	4. Examine insulation of terminal wiring and ensure that terminal connections are sound.
5. Micro switches.	5. Check effectiveness of contacts and tightness of fixing screws.
6. Thermal insulation of pipe-work and chamber.	6. Examine and pay particular attention to safety aspect of exposed hot surfaces.
7. Thermocouple connections.	7. Check and pay special attention to tightness of entry points into the chamber or air detector.
8. Water-sealed vacuum pumps.	8. To be opened up and any lime and other deposits removed. (This task need only be undertaken if the pump is operated with water known to cause deposits.) Makers' instructions to be studied carefully for each stage of work.
9. Condensers and heat exchangers.	9. Check effectiveness.
10. Reducing valves.	10, 11, 12, 13. Check all parts. Renew seats, discs, packings, gaskets and diaphragms as necessary.
11. Spring operated valves.	
12. Hydraulic, steam and air-operated valves.	
13. Non-return valves.	
14. Air filters.	14. To be replaced as necessary.
15. Chamber door safety lock diaphragm.	15. To be replaced, see also under Weekly Tasks, 3.

Yearly Tasks

Part concerned	Notes
1. Steam safety valves.	1, 2, 3. Dismantle and check all parts. Renew seats, discs, packings and gaskets as necessary. Test and adjust.
2. Compressed air relief valves.	
3. Isolating valves.	
4. Control valves camshaft.	4. Examine for alignment and wear.
5. Electric motors.	5. To be checked and bearings re-packed with grease. (Refer to maker's instructions.)
6. Vacuum pump—roller bearings.	6. To be re-packed with approved grease. (Refer to maker's instructions.)
7. Vacuum pump—gland.	7. Renew packing.
8. All parts of sterilizer.	8. A general check.

TWO-YEARLY TASKS

Part concerned	Notes
1. Sterilizer complete, and associated equipment.	1. Prepare for Engineer Surveyor's examination.

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